Control Center System   Vision 2000 Correspondence

To: J. D'Angelo / D. West / J. Spiegel

From: G. Welter
Comments: J. Whetzel, C. Fatig, A. Biebel

Date: 12-Feb-96

Subject: PRS Requirements (Revision J - March 94); Mapping to Vision DLPs

CCS

Key for mapping:
REQ 101 - Unknown whether we need an associated DLP (or if one has been written).
REQ 102* - I suggest that the requirement is unneeded.
REQ 103 - I think this requirement is needed, but associated DLPs have not been written
(to the best of my understanding).
REQ 104* - An analogous function is needed, but probably significantly modified.
REQ 105 - I think this requirement is needed; DLPs are partial.
REQ 106 - I think this requirement is needed; DLPs are partial, but mostly complete.
REQ 107 - I think this requirement is needed; DLPs exist.

Section 1 - Introduction (no specific requirements; just an overview)

Section 2 - Telemetry and Command (TAC) Processor
TAC 201 - Ground configuration for telemetry reception
(a) Accept requests to control TAC configuration and operation
(b) Allow ground system reconfiguration required for telemetry formats and rate
> *The Monitor group has written DLPs for FEP/TAC configuration with regard to telemetry reception. I don't think analogous DLPs for commanding exist. Also, although we have assumed the existence of a general resource manager, I don't think DLPs have been written for it.*
> *Monitor DLP 4.2.1.1.6*

TAC 202 - Utilize catalogs to specify the processing to be performed on different data streams. These catalogs shall allow for temporary parameter modification.
> *The Monitor group has written DLPs that indicate that the FEP must be able to automatically recognize and switch telemetry format processing. Whether this is done with "catalogs" or some other mechanism is not terribly important.*
> *Monitor DLP 4.2.1.1.6*

TAC 203 - Generate catalogs based on data base information.
> *We have not specified anything about how PDB information will be incorporated into the operational system.*

TAC 204* - Nominal (via Nascom/TDRS) communications.
(a) Input line requirements: 3 lines using 1.544 Mb/s, 56 Mb/s, 56 Mb/s
(b) Allow line outage recorder playback from NASCOM
(c) Accept simulator input
(d) Transmission line to HST requirement: 1 line using 9.6 kb/s, 4800 NASCOM blocks
(e) Transmission line to OSS: 1 line using 1.544 Mb/s
> *The Monitor team has specified some data volume requirements. Nothing has been specified regarding line outage playback. Simulation support has been specified. Command volume requirements not specified. Transmission to OSS not specified.*
> *Curt notes/suggests: "What about IP CMD/TLM, not 4800 block?"*
>   *Monitor Metrics document*

TAC 205* - Communications (in & out) through GSTDN
(a) Two input lines: for real-time and recorder dump support
(b) One output line for commanding
> *Nothing has been specified vis-a-vis GSTDN.*
> *Curt notes: third input line required for echoes. Emphasizes that GSTDN support is required.*

TAC 206* - Communications (in & out) through DSN (similar to GSTDN support)
> *Nothing has been specified vis-a-vis DSN.*
> *Curt emphasizes that DSN support is required.*

TAC 207 - Receive (HST telemetry) data from JSC.
> *Monitor has a DLP to cover receipt of shuttle data (e.g., FSS, ORUC), but not HST data transmitted through the shuttle.*
> *Curt notes: two input lines required - TLM, CARS (what does CARS mean?)*
> *Curt asks "What about JSC commanding? various modes, 1-step / 2-step"*

TAC 301 - Display HST telemetry quality statistics.
>   *Monitor DLP 4.2.1.1.4*

TAC 302 - Accumulate HST telemetry quality statistic.
>   *Monitor DLP 4.2.1.1.4*

TAC 401 - Data processing requirements for (a) test data, (b) simulator data, (c) real-time HST data, and (d) line outage playback data. Assumes NASCOM interface.
> *Items a, b, & c have been covered by the Monitor group.*
>   *Monitor DLP 4.3.1.1.1 - 4.3.1.4.5*

TAC 501 - Transmit spacecraft command data via one simplex 9.6 kb/s communications line, externally clocked. Assumes NASCOM interface.
> *This is logically an FEP command function. The only FEP functionality so far written is that for telemetry reception written by the Monitor group; no FEP command function DLPs have been written.*

TAC 502 - Transmit fault isolation messages (as needed) - to NCC or HST simulator. Response is (currently) via voice communications.
> *Fault isolation DLPs have not been written.*

TAC 503 - Interface test message to HST simulator. Response is (currently) via voice communications.
> *Interface test DLPs have not been written, although test & simulation DLPs have.*

TAC 601* - Receive and process HST science real-time data stream and forward to science data to the OSS. Channels: 4 kb/s on MA, 1.024 Mb/s on SSA.
No longer a STOCC requirement. (Science data sent to STScI by PACOR.)

TAC 602* - Transmit real-time or recorder dump science data to OSS over a simplex 1.544 Mb/s communications circuit.
No longer a STOCC requirement. (Science data sent to STScI by PACOR.)
BUT why then is this requirement being updated in CCR 1941 (5/25/95)?

TAC 603* - Provide periodic "keep alive" message to OSS when OSS science data output is enabled but no data are being processed.
No longer a STOCC requirement. (Science data sent to STScI by PACOR.)

TAC 604 - Provide OSS (OPUS) communications link test message.
  Monitor DLP 4.2.4.2.8

TAC 605* - Search for, recognize, extract, and forward the following data sets from the science data link for processing by the Dump Processing Subsystem: NSSC-1 Status Buffer, NSSC-1 Dump, FOC Microprocessor Dump, FOS Microprocessor Dump, & Coprocessor Dump.
No longer a STOCC requirement. (Science data sent to STScI by PACOR.)

TAC 701 (*?) - Automatically record incoming real-time engineering data if LAN communications or archiving has become disabled. Minimum record capacity: 30 minutes of 30 kb/s data.
DLPs exist for an expert system to recognize and respond to ground system anomalies; no DLPs exist for temporarily storing interrupted real-time telemetry data until the associated problem has been repaired. Such DLPs will not be needed if (a) essentially all data have been stored on the on-board recorder, or (b) we decide that we can live with the data loss.

TAC 702 - Stage up to two full tape recorder dumps (ETR and STR) simultaneously. Reverse tape data for use by downstream systems.
ETR/ESSR processing DLPs covered by Monitor system; STR/SSSR related DLPs not written. Science data processing is currently done by PACOR.
  Monitor DLP 4.2.1.1.1-7

TAC 703 - Accept and process ETR data. Apply minor frame quality indicators.
  Monitor DLP 4.2.1.1.1-7

TAC 704* - Accept and process STR data.
No longer a STOCC requirement. (Science data sent to STScI by PACOR.)

TAC 705 - Accept and process ETR data. Handle transitions between 4 & 32 kb/s data.
  Monitor DLP 4.2.1.1.1-7

TAC 706 - Replay real-time history or ETR data.
No DLPs exist for a replay of data.

TAC 707* - Replay STR data to OSS. (See spec for detail.)
No longer a STOCC requirement. (Science data sent to STScI by PACOR.)
BUT why then is this requirement being updated in CCR 1941 (5/25/95)?

Section 3 - Telemetry Distribution

XMT 101* - Provide node for telemetry distribution. - *Resource manager.*

XMT 102 - Accept any of the valid telemetry formats and rates. Distribute data to (PRS) systems that require them for subsequent processing.
  Monitor DLPs 4.2.1.1.1 - 4.2.1.4.5

XMT 103 - Provide data to the off-line system (PASS)
  Covered by Monitor system (in so far as PASS post-processing [e.g. AD&SC] becomes part of CCS). Once data are archived, they are generally available.
  Monitor DLPs 4.2.1.4.1-5

XMT 104 - Provide data to ESS.
  Covered by Monitor system (in so far as ESS becomes part of CCS).
  Monitor DLPs 4.2.1.4.1-5

Section 4 - Telemetry Processing

TLM 101* - Allocate Telemetry processing node. - *Resource Manager.*

TLM 102 - Detect and report format changes. Upon receiving confirmation of format change, switch to proper decommutation format.
  Covered by Monitor system, with assumption that it will be automated.
  Monitor DLP 4.2.1.1.6

TLM 103 (?) - Detect missing minor frames. Flag questionable quality data.
  This is at least partially covered by Monitor DLPs. It is not clear how detailed the DLPs should be in this area. We have found with the PASS system that one has to be very careful with minor frame validation to properly identify whether we are dealing with data gaps or vehicle time / minor frame counter corruption.
  Monitor DLP 4.2.1.1.4

TLM 104 - Decommutate engineering data.
  Monitor DLP 4.2.1.1.9

TLM 105 - Perform context-dependent decommutation.
  Monitor DLP 4.2.1.1.9 (implicit)

TLM 106 (?) - Perform special decommutation for item using multiple and non-contiguous bits and words and for the application of special raw data construction logic.
  This may be implicitly covered by Monitor system DLPs, although it appears to be at a level of detail deeper than are discussions went.
  Monitor DLP 4.2.1.1.9 (implicit)

TLM 107* - Store last received and decommutated values for use by other elements of system.
  Monitor DLPs exist for storing all data; but no special thought is given to holding the most recent value for each item in a separate buffer. (This may be just a language problem; the Monitor system current state table will hold the most recent value of all monitored mnemonics during static periods - e.g., ZOEs.)

TLM 108 (*?) - Mark telemetry and algorithm results as static during periods of data dropout.

As written, this requirement seems to expect that real-time telemetry items are being displayed for human to view.   This is not expected to be standard operations. However, for internal monitor purposes, DLPs exist for a heartbeat message to be sent to the expert system inference engine so that it will know when telemetry data are not being received.
Monitor DLP 4.2.2.3.5

TLM 109 - Perform engineering unit (EU) conversion.
Monitor DLP 4.2.1.1.10

TLM 110 - Perform context dependent EU conversion.
Monitor DLP 4.2.1.1.10

TLM 111 - Perform limit checking of telemetry and derived parameters.
Monitor DLP 4.2.2.1.1 - 4.2.2.3.6 & 4.1.1.2.3 - 4.1.1.5.5

TLM 112 - Perform limit checking. [Seems like part of TLM 111]
Monitor DLP 4.2.2.1.1-6 & 4.1.1.2.3-5

TLM 113 - Allow limit adjustment during operations without PDB change.
Monitor EBP written (Develop & Test New Procedures); no DLP.

TLM 114 (*?) Allow bi-level dependent limit set selection.
Either implicitly covered by DLPs associated with TLM 111, or more detail required in the DLPs. Curt suggests that explicit detail should be included.

TLM 115 - Report limit violations.
Monitor DLP 4.1.3.1.1-13 & 4.2.5.1.1-15

TLM 116 - For specified mnemonics, apply limit (delta) checking to change between telemetry occurrences.
We did not consider delta checking; is it still desired?
Curt notes that this item is closely related to TLM 117. If delta checking is done to evaluate the noise quality of data, then perhaps this is implicitly covered.

TLM 117 - Report occurrences of noisy data.
Monitor DLP 4.1.1.1.4

TLM 118 - Apply special equation processing to selected telemetry items.
Not covered; should be a Monitor system DLP.

TLM 119 (*?) - Apply special "derived parameter" processing: (a) deleted, (b) sun position in spacecraft coordinates, (c) sun position in SA coordinates, (d) temperature differential maximums for light shield assembly & forward shell, (e) HST attitude from OBC PCS, (f) FGS star selector positions - true vs. expected (report miscompare), (g) allow nonprocessing of inactive ORU/IRU items, (h) monitor CDI counter - report commanding problems.
These would be Monitor functions. DLPs are not at this level of detail.
Curt suggests that some appropriate DLP (perhaps in the Analysis and Trending area) be augmented to include these items. The issue of whether this processing should be done as part of monitoring preparation or analysis & trending depends upon whether we want immediate feed-back on deviations between the expected and true states.

TLM 120 - Monitor expected vs. true values for selected mnemonics; report results.
  Monitor DLP 4.2.2.1.1 - 4.2.2.3.6, 4.2.5.1.1-15 & 4.1.1.2.3 - 4.1.1.5.5, 4.1.3.1.1-13

TLM 121 (*?) - Allow specification of alternative sets of items for monitoring.
    Covered by Monitor system; however not as alternative sets. All specified telemetry sets are monitored all the time.
  Monitor DLP 4.2.2.1.1 - 4.2.2.3.6, 4.2.5.1.1-15 & 4.1.1.2.3 - 4.1.1.5.5, 4.1.3.1.1-13

TLM 122 (*?) - Provide computations for mean and other derived OTA thermal monitoring.
    The Monitor system DLPs provide a place for derived parameters and general trending. TLM 122, in specifying OTA thermal computations, is more detailed than our DLPs. However, consider comments following TLM 119.
  Monitor DLP 4.1.1.6.1-12

TLM 123 (*?) - Apply limit checking to OTA thermal computations.
    See TLM 122 note.
  Monitor DLP 4.1.1.6.1-12

TLM 124 (*?) - Report results of OTA thermal computations.
    See TLM 122 note.
  Monitor DLP 4.1.1.6.1-12

TLM 125 - Allow nonprocessing of inactive ORU/IRU OTA thermal items.
    We have not considered the issue of switching between one set of ORU/IRU items and another during a servicing mission, nor of coordinating the jump through a servicing mission when extracting archive data. For that matter, we haven't considered problems associated with jumping across a PDB change when extracting data from the archive. (Regarding OTA, see TLM 122 note.)

TLM 126 - Extract OSS subset; transmit data to OSS.
    No explicit DLPs have been written for transmission of data to OSS. Negotiations are required between CCS and P&S to determine how AEDP functionality should be moved into the V2K era.

TLM 127* - Extract selected data for strip-chart recorder (SCR) plotting.
    CRT plotting should be available; SCRs should be eliminated.

TLM 128 - Upon request, strip WF/PC microprocessor dump data from engineering minor frames.
    No DLPs have been written explicitly considering WF/PC microprocessor dump data. If this is fundamentally the same as OBC dump data, just from a different computer, then the Monitor DLPs have covered the requirement implicitly. We may, however, want to expand the specification with that DLP to make explicit reference to any onboard microprocessor dumps of interest.
  Monitor DLP 4.2.1.1.15-16

Section 5 - Dump Processing
DMP 101* - Allocate dump processing node. - *Resource manager.*

DMP 102/A - Collect and store data from the following: (a) DF-224 dumps, (b) NSSC-1 dumps (single banks), (c) NSSC-1 status (entire memory), (d) FOC dumps (entire memory), (e) FOSA & FOSB dumps (entire memory for each), (f) deleted, (g) WF/PC dumps (continuous memory - entire memory), (h) Coprocessor dumps (221 byte areas), (i) STIS, (j), NICMOS.

> *Monitor DLPs exist - at least implicitly - for (a), (b), & (h). No DLPs have been written explicitly considering other microprocessor dump data. If this is fundamentally the same as OBC dump data, just from a different computer, then the Monitor DLPs have covered the requirement implicitly. We may, however, want to expand the specification with that DLP to make explicit reference to any onboard microprocessor dumps of interest.*
> *Monitor DLP 4.2.1.1.15-16, 4.2.1.3.3, 4.2.1.4.5*

DMP 103 - Construct dump best estimate image for each dump type.
> *See note for DMP 102. No DLPs exist for construction of best estimate image.*

DMP 104 - Compare ground master image (GMI) against spacecraft image.
> *See note for DMP 102.*
> *Monitor DLP 4.1.1.2.9*

DMP 105 - Allow update of GMI using dump information.
> *See note for DMP 102. GMI update not considered.*

Section 6 - Command
CMD 101* - Allocate command node.
> *Implicit requirement exists, but not needed explicitly.*
> *Alice comments: This is really an environment/set up issue. I believe it belongs in the Resource Manager area. (Note: there are no RM DLPs. [gw])*

CMD 102 - Assemble discrete real-time commands (RTCs) from PSTOL command mnemonic requests based on pre-established data base input.
> *Jane notes that C&U DLPs 3.1.2.4.4-5 "are meant to cover any type of uplink."*
> *Alice comments: This is covered by the Create Binary Commands EBP and it's associated DLP's.*
CMD 102a (Implicit requirement) - Create PSTOL RTC command mnemonic requests.
> *The C&U team assumes that other systems (e.g., users, Monitor, etc.) know how to construct valid command requests based on some kind of specified template. Although the Monitor system DLPs do specify that it will send command requests to the Command system, there is no spcification of how (e.g., no indication of input Data Base templates) to do this. The Monitor system probably needs a DLP or two specifying how it does this. We may want to indicate in that DLP that the interface to the command assembly procedure/program must be such as to allow either automatic command request construction (by the Monitor system, e.g., for an ARU/PRT), or human controlled to allow the MEs a standard package.*

CMD 103 - Apply one of two spacecraft decoder addresses.
> *Covered by C&U Spacecraft Data Get DLP (DLP 3.1.2.4.5).*

CMD 104 - Apply hamming code.
> *Covered by C&U Hamming Code Calculate DLP (DLP 3.1.2.4.7).*

CMD 105 - Allow commanding to select between redundant spacecraft devices.
> *Covered by C&U Command Data Get DLP (DLP 3.1.2.4.4).*

CMD 106 - Assemble data RTCs based on PDB input.
> *Covered by C&U Create Binary Commands EBP and associated DLPs (DLPs 3.1.2.4.4 - 8). However, see comment following CMD 102a.*

CMD 107 - Construct data portion of data RTCs.
> *Covered by Create Binary Command EBP and associated DLPs (DLPs 3.1.2.4.-). However, see comments for CMD 102a.*

CMD 108 - Retain data field values for most recently assembled RTCs; allow modification without uplink.
> *Alice opines that this is an implementation issue for the Create Binary Command EBP (DLPs 3.1.2.4.-). Curt asks "Is this ability is ever used by Ops?"*

CMD 109 - Provide (PRS) system "cold" restart system initialization RTC values.
> *No DLPs exist for "cold" restart. Jane notes: "This is an implementation issue and may not have any DLPs. We don't really know what the data base interface is yet and that would drive this requirement." Alice suggests that this is part of the environment/set up issue for Resource Manager area.*

CMD 110 - Validate command data configurations.
> *Covered by C&U Validate Command Requests (DLPs 3.1.1.1.-).*

CMD 111 - Allow specification of certain commands as critical.
> *No DLPs for special command labeling exist. Jane notes that we don't yet know how critical commands should be handled; a Project decision is needed here. Curt claims that such specification is needed for some JSC command requirements. Alice notes: Need DLP here, probably right before Command Send DLP.*

CMD 112 - Report intent to send critical commands.
> *Alice notes: Need DLP here, probably right before Command Send DLP.*

CMD 113 - Verify (from master console) acceptance of critical command issuance.
> *Alice notes: Need DLP here, probably right before Command Send DLP.*

CMD 114 - Provide command buffer.
> *Alice notes: Part of the environment/set up issue for Resouce Manager area.*

CMD 115 - Maintain a library of approved RTC binary form groups.
> *Alice notes: Part of the environment/set up issue for Resouce Manager area.*

CMD 116 - Using PSTOL interface, retrieve and uplink user designated RTC groups.
> *C&U Command Data Get DLP (3.1.2.4.4) and Command Send DLP (3.1.2.2.2).*

CMD 117 - Allow critical command verification for RTC groups.
> *Alice notes: Need DLP here, probably right before Command Send DLP.*

CMD 118 - Accept, catalog, and store OFLS-provided loads for: (a) OBC memory load images (DF-224, NSSC-1, STIS, & NICMOS), (b) Stored Program Command (SPC) loads (DF-224 & NSSC-1), (c) Data table loads (DF-224, NSSC-1, FOS, FOC, & WF/PC).
> *Jane comments: "This may require new code (DLPs?) [for the Command/Uplink system] depending on how/where data (i.e., loads) will be formatted/reside."*

Alice believes that DLP needs are covered by Command Data Get DLP.

CMD 119 - (Using PSTOL request,) retrieve and uplink OBC memory (flight software) load images for DF-224 & NSSC-1. (22 detailed requirements)
CMD 119A - (Using PSTOL request,) retrieve and uplink STIS & NICMOS Micro-processor memory load uplinks. (21 detailed requirements)
> *C&U Command Data Get DLP (3.1.2.4.4) and Command Send DLP (3.1.2.2.2), however it seems clear that the DLPs do not go to the level of detail that the authors of the PRS requirements thought necessary. Jane notes that a decision has not been made that PSTOL will be retained as the command line language.*

CMD 120 - (Using PSTOL request,) retrieve and uplink user designated SPC loads, with the implied retrieval and uplink of associated RTS loads for a user requested ATP load of the NSSC-1. (14 detailed requirements)
> *C&U Command Data Get DLP (3.1.2.4.4) and Command Send DLP (3.1.2.2.2). Again, note uncertainty about PSTOL; but there will need to be some mechanism to keep the coupling of RGS/ATP loads.*

CMD 121 - (Using PSTOL request,) retrieve and uplink user designated tables or portions of tables for DF-224, NSSC-1, & appropriate microprocessor tables. (26 detailed requirements)
> *C&U Command Data Get DLP (3.1.2.4.4) and Command Send DLP (3.1.2.2.2). Again, note uncertainty about PSTOL.*

CMD 122 - (Using PSTOL request,) patch DF-224, NSSC-1, STIS, & NICMOS flight software. (12 detailed requirements)
> *C&U Command Data Get DLP (3.1.2.4.4) and Command Send DLP (3.1.2.2.2). Again, note uncertainty about PSTOL.*

CMD 123 - Allow critical command verification for OFLS-provided data.
> *Alice notes: Need DLP here, probably right before Command Send DLP.*

CMD 124 - Organize & coordinate command buffer uplinks through Nascom/TDRSS.
> *Alice opines that this is covered by Command Send DLP. However, C&U DLPs coordinate timing and schedule, and send command information to CCS FEP. No DLPs exist to actually send commands on from the FEP to Nascom. Jane asks "Is FEP the interface to Nascom?"*

CMD 125 - Provide proper metering for command data through Nascom/TDRSS.
> *C&U Command Send DLP (3.1.2.2.2).*

CMD 126 - Buffer command data into Nascom blocks. (19 detailed requirements)
> *Covered by C&U Command Block Assemble DLP.*
> *Jane notes: "The current DLPs address a majority of modes for generic data but specifically address TDRS only. (i.e., JSC, GSTDN not specifically addressed.) Curt suggests using IP blocks.*

CMD 127 - Apply required spacecraft introduction data patterns.
> *C&U Command Block Assemble DLP (3.1.2.5.1).*

CMD 128 - Apply required spacecraft postamble pattern
> *C&U Command Block Assemble DLP (3.1.2.5.1).*

CMD 129 - Allow merged or distinct command buffering and sending actions.
The requirement assumes human-in-the-loop design. Jane notes that this could be accomplished in an automated way if need be. Curt notes that manual control of commanding will likely be "normal" during servicing missions. Alice believes that this is covered by implementation of C&U Command Block Assemble DLP.

CMD 130 - Allow command abort option for commands spanning multiple buffers.
The C&U system does allow command interrupts, but I think this is only in the context of placing a higher prior command into the queue. Alice confirms that a DLP is needed for abort option.

CMD 131 - Allow command retransmissions.
C&U Command Send DLP (3.1.2.2.2).

CMD 132 - Allow command retransmission from point of failure.
C&U Command Send DLP (3.1.2.2.2).

CMD 133 - Retransmit entire buffer for OBC memory load operations.
C&U Command Send DLP (3.1.2.2.2). However, Jane notes that, depending on how the verification process is done, entire loads may need to be retransmitted rather than buffers.

CMD 134 - Provide event message for each command transmission.
C&U Command Send DLP (3.1.2.2.2).

CMD 135 - Archive all (optional) transmitted HST commands.
C&U Command Block Store DLP (3.1.2.5.2).

CMD 136 - Using PSTOL, provide verification options: (a) no verify, (b) verify using command-accept counter, (c) verify using command-accept counter and/or OBC load checksum-accept flags (as appropriate), (d) verify using command-accept counter and/or block counters (DF-224 software loads). (10 detailed requirements)
C&U Validate Command Uplink EBP and it's DLPs (3.1.2.6.-), however the use of checksum validation is expected to be eliminated. (Curt expressed surprise at my comment about the elimination of checksum validation. Perhaps I've got it wrong, but it was my understanding that CDI counter validation was thought to be sufficient for command load validation. What do the experts say?)

CMD 137 - Allow commands without verification.
C&U Validate Command Uplink EBP and it's DLPs (3.1.2.6.-).

CMD 138 - Allow command-accept counter verification.
C&U Validate Command Uplink EBP and it's DLPs (3.1.2.6.-).

CMD 139* - Allow OBC load checksum verification.
To be eliminated; CDI verification has proven to be adequate. (Alice agrees.)

CMD 140 - Report number of commands and command words transmitted and verified.
C&U Last Block Alert Get DLP (3.1.2.6.3).

CMD 141 - Suspend commands upon verification failure.
C&U Command Send DLP (3.1.2.2.2).

CMD 142 - Enable / Disable end-action verification.

C&U Command Send DLP (3.1.2.2.2).

CMD 143 - Allow OBC load suspension with RTC insertion. (11 detailed requirements)
Alice: "C&U DLP needed for this item."

CMD 144 - Apply dump time UTC value to STR data dumps (for use by DCF).
Alice: "Covered by implementation of Command Data Get DLP and Command Word Format DLP." Gary: I think we probably need time assignment to be explicit; perhaps this could be done with just some clarifying words added to the two DLPs indicated by Alice. Curt asks "Why do we care about science recorder unless SI microdumps are on that recorder?" Gary replies: CCS MEs may not care per se - but DCF/PACOR needs the time, so we have to supply it.

CMD 145 - Generate and transmit DF-224 safing activation & deactivation commands.
Alice note that a DLP is needed for this requirement.
Curt comments: "I believe this is /safe_on /safe_off. We can do better with spacecraft commands than depending on ground commands."

CMD 146 - Allow redundant verification of critical commands.
C&U Command Send DLP (3.1.2.2.2); however, see note for CMD 111.

CMD 147 (*?) - Create memory loads from OBC/Microprocessor master images.
Jane notes: "If this is a requirement, it logically fits here. There was some discussion as to whether or not it's useful or necessary." Alice says: "This is covered by implementation of Command Block Store DLP." Curt comments: "I don't think that Ops has ever done this." Gary notes: "It was not clear to me that this is covered; perhaps the DLP should be made more explicit."

CMD 148 (*?) - Create ground master images (GMIs) from non-uplinked load files.
Jane notes: "There was some discussion about this. To the best of my knowledge, Archive was going to maintain GMIs with inputs form C&U." Monitor has not written DLPs to create GMIs. Where is the creation expected to be done? Curt says it is a CCS function. Alice says: "This is covered by implementation of Command Block Store DLP." Gary notes: "It was not clear to me that this is covered; perhaps the DLP should be made more explicit."

CMD 149 (*?) - Create GMIs from uplinked load files.
See notes following CMD 148. Curt says this is a CCS function.

CMD 150 (*?) - Update GMIs based on Project-provided (tape) input.
See notes following CMD 148. Curt says it would be nice for testing.

CMD 151 (*?) - Backup GMI, Load, and Schedule files.
Jane opines that this will probably not be necessary on the new platform. Why not? Curt thinks it should be done, suggesting "save for TBD time, maybe first in last out and save 2 or 3 versions." Alice says: "This is covered by implementation of Command Block Store DLP." Gary notes: "It was not clear to me that this is covered; perhaps the DLP should be made more explicit."

Section 7 - Display
It is rather hard to judge what is required as carry over requirements at a DLP level for a Display system. From a abstract perspective, the details of the display system seem unimportant; however, from a computer systems and human factors perspective, the

details for what is displayed and how the display is presented can be very important. I think comparatively little thought has gone into such considerations so far. I don't know to what extent such details are needed for DLPs.

DSP 101* - Allocate Display subsystem node.   -   *Resource manager.*

DSP 201* - Provide keyboard (PSTOL) system for (PRS) control.
NOTE: "The DOC provides for hardware configuration system, loading and initialization, system monitoring, and failover."   -   *Resource manager.*

DSP 202* - Provide keyboard function key capability (to reduce keystrokes).
    Too low level?

DSP 203 - Allow MicroVIP page selection.
    DLPs exist for user-selectable displays.
    e.g., Monitor DLPs 4.1.1.9.-, 4.1.3.6.-, 4.2.2.5.-, 4.2.5.6.-

DSP 204* - Allow workstation mouse control.   -   *Too low level?*

DSP 205 - Allow workstation general STOCC LAN access.
    Architectural issue, are DLPs needed?

DSP 206* - Allow most recent PSTOL line recall and editing.
    Too low level? [Curt: yes]

DSP 207* - Manage screen (designate current page; one or four pages on screen).
    Too low level? [Curt: yes] DLPs exist for user-selectable displays.

DSP 301 - Allow about 300 predefined telemetry pages, plus user-definable pages.
    DLPs exist for user-selectable displays.
    e.g., Monitor DLPs 4.1.1.9.-, 4.1.3.6.-, 4.2.2.5.-, 4.2.5.6.-

DSP 302* - Display raw or EU-converted; decimal, octal, hex, or binary.
    Too low level? [Curt: include DLP] DLPs exist for user-selectable displays.

DSP 303* - Allow CRT scrolling pages.
    Too low level? [Curt: yes] DLPs exist for user-selectable displays.

DSP 304* - Allow screen freeze (during hardcopy production).
    Too low level? [Curt: yes] DLPs exist for user-selectable displays.

DSP 305* - Allow page specification for video distribution and/or hardcopy.
    Too low level? [Curt: include DLP] DLPs exist for user-selectable displays.

DSP 306 - "Two-step PSTOL capability"
    Curt: "Used when HST is in orbiter; commanding through TDRS to HST direct needs to be inhibited. We need DLP for this; it's a JSC command issue."

DSP 307 - Provide subsystem alarm capability for limit violations display.
    Intent is covered by Monitor system Inference Engine DLPs.
    Monitor DLPs 4.1.3.1.- & 4.2.5.1.-

DSP 308* - "Telemetry Pages" - seems a repeat of DSP 301 & 302. ?
    See notes for DSP 301 & 302.

DSP 309 - Display static, limit violation, and delta violation status.
>*Covered by Monitor system, except delta violations not considered.*
>*Curt notes that "delta violation" is a noise quality check.*

DSP 310 - Display command buffer contents.
>*C&U DLP 3.1.1.2.12.*

DSP 311* - Provide buffer and display capability for (a) last 162 printer event monitor entries, (b) last 162 system alarms (e.g. out-of-limit conditions), (c) last 152 PRS internal configuration messages, (d) last 162 command and ground configuration message requests and verification status, and (e) a configuration monitor page.
>*Too low level? Curt opines that it is too low level.*

DSP 312 - Display TDRSS schedule.
>*C&U DLP 3.1.1.2.2 (implicit - information available, displayable if needed).*

DSP 313 - Display current limits; display designated raw and converted telemetry values.
>*Monitor DLPs 4.1.1.2.- - 4.1.1.5.- & 4.2.2.1.- - 4.2.2.3.-*
>*(implicit - information available, displayable if needed).*

DSP 314 - Display current RTC parameter values.
>*C&U DLP 3.1.2.4.4 (implicit - information available, displayable if needed).*

DSP 315* (?) - Log all command dialogue messages.
>*As written, this assumes human-in-the-loop system. However, Curt notes that we may want a log of system messages.*

DSP 316* - Allow full or condensed description of command buffer contents.
>*Too low level?]Curt: yes]*

DSP 317 - Display data base attributes of telemetry mnemonics, derived parameter mnemonics, & general equation mnemonics.
>*No DLPs exist. Ask Data base or archive group to advise on what's useful.*

DSP 401* - Allow pre-defined line printer reports.
>*Goal should be paperless system; reports should be in on-line format.*

DSP 402 (?) - Allow printing of CRT displays.
>*Should this be an infrastructure requirement?*

DSP 501 - Allow user-defined telemetry displays. (18 specific requirements)
>*I think this is covered generically, but without details.*
>*Monitor DLPs 4.1.1.2.- - 4.1.1.5.- & 4.2.2.1.- - 4.2.2.3.-*

DSP 502* - Allow user-defined line printer reports.
>*Goal should be paperless system; reports should be in on-line format.*

DSP 503 - Allow user-defined telemetry displays; raw or EU.
>*Monitor DLPs 4.1.1.2.- - 4.1.1.5.- & 4.2.2.1.- - 4.2.2.3.-*

DSP 601* - Print pre-formatted bulk dumps.
DSP 602* - Print best estimate images (see DMP 103).
DSP 603* - Print dump comparison reports (see DMP 104)

DSP 604* - Print DF-224 safing region freeze data region.
DSP 605* - Print NSSC-1 status buffer report.
DSP 606* - Print operational period catalog report.
DSP 607* - Print command load directory report.
DSP 608* - Print command load listings.
DSP 609* - Print schedule directory reports, including TDRS schedule.
DSP 610* - Print ground master image reports for OBCs.
DSP 611* - Print RTC group table of contents report.
DSP 612* - Print specified RTC groups.
DSP 613* - Print planned data descriptive reports (loads & groups).
DSP 614* - Print OTA thermal report.
> *Goal should be paperless system; reports should be in on-line format.*
> *Curt notes, regarding 606, that the use of OPC is being deleted.*

DSP 701 (*?) - Store display & report information to microfiche.
DSP 702 (*?) - Generate microfiche-compatible tapes.
> *Is microfiche the best storage format currently? Probably not.*

DSP 801 - Generate CRT graphic displays of selected parameters vs. time.
DSP 802 - Allow user-defined graphic displays.
> *Implicit, part of Monitor Trending and Analysis system.*
> *Monitor DLPs 4.1.1.6.-*

DSP 803 (?) - Allow (rapid) user selection of graphic pages.
> *A performance definition for "rapid" must be provided.*

DSP 804 - Display real-time graphics of FGS telemetry data calculations.
> *No DLPs exist for this type of function; the function is probably needed to support certain real-time test/verification activities (e.g., new flight software algorithm for FGS data processing). Curt suggests that there really is nothing special about FGS calculations in this regard. From this perspective, it may be noted that it would be highly desirable to have an analysis & trending COTS package that allows the user to implement fairly sophisticated computations and associated displays rapidly. We may need some more discussion / clarification as to what should be hard-coded, vs. what facilities are needed for rapid analysis development.*

DSP 805 - Allow PDB-defined graphics pages.
> *Covered for Monitor system; maybe all for which it is meaningful.*
> *e.g., Monitor DLPs 4.1.1.9.-, 4.1.3.6.-, 4.2.2.5.-, 4.2.5.6.-*

DSP 901 - Process, display, & log (PRS) system event messages (includes hardware status, software status, communications circuit quality, & data quality).
> *The Monitor system design is aimed at problem detection and analysis. We don't have it designed to maintain knowledge of general system status, except when the status becomes anomalous. Should we reconsider this? Curt believes that it is important to have logging of nominal conditions in order to (a) track system context just before an anomaly, or (b) to just allow users to check on things. Perhaps we need something like a MEGG for the ground system that can be annotated with respect to success or failure of planned events?*

DSP 902 - Display problems identified on remote (PRS) nodes.
> *Covered by Monitor system (ground monitoring), DLPs 4.2.4.1.-*

DSP 903 - Display event messages.
See DSP 901. See comments following DSP 901.

DSP 904* - Allow printing of event messages.
Goal should be paperless system; reports should be in on-line format.

DSP 1001* - Provide strip chart recorder (SCR) display of (up to 12) selected analog telemetry, derived parameter, and/or general equation values.
DSP 1002* - Provide strip chart recorder (SCR) display of (up to 12) selected event telemetry, derived parameter, and/or general equation values.
DSP 1003* - Allow user specified SCR displays.
DSP 1004* - Maintain SCR active pen matrix.
DSP 1005* - SCR shall have 1 pen marking time to 0.1 sec accuracy.
Replace SCR with CRT graphics.

DSP 1101 - Time displayed on CRTs to 1 sec; time on history log to 0.001 sec.
General performance requirements for CCS are required.

DSP 1102 - Convert vehicle time in counts to UTC.
MonitorDLPs 4.2.3.3.- & 4.2.1.1.12

DSP 1103* - Compute time difference between spacecraft UTC and PRS ground time.
It is not clear that this time difference (primarily for SCR plots) is useful.

DSP 1201 - Provide MicroVIP HELP facility.
No on-line HELP DLPs exist. The requirements / conventions for on-line help is a non-trivial issue; thought must be given to it. We would want some kind of programmer's guide for this, but probably not DLPs.

Section 8 - PSTOL
PSTOL is the PRS control language. I will interpret the requirements here as pertaining to CCS in cases where it applies. We actually may want to consider retaining the basic PSTOL syntax - and wherever possible the exact format - to minimize the negative implications for verifying a new control language, and for other users (e.g., test groups) to verify new command procedures. No explicit requirements for a CCS control language have been written, although it is clear that some form of control language, even if only that native to the selected operating system, must exist. Curt notes that it would be nice to have a more versatile language.

PSTL 101* - Allocate PSTOL subsystem node. - *Resource Manager.*

PSTL 102 - Provide PSTOL language for general (PRS) system control.
See section 8 leading note.

PSTL 103* (?) - Allow master console to assign full or partial PSTOL control to other workstations.
No DLPs for a master console have been specified. Curt thinks that it may be useful to have one, particularly during servicing mission support.

PSTL 104 - Allow OSS to send a restricted set of PSTOL commands.
Negotiations with STScI as to their needs is required.

PSTL 105* - Task synchronization shall be done using PSTOL.

PSTOL is for human control of system; most task synchronization should be automated.

PSTL 106 - PSTOL shall allow a number of programming functions (GOTO, etc.).
See section 8 leading note.

PSTL 107 - PSTOL directives can be combined as PSTOL procedures.
See section 8 leading note.

PSTL 108 - Control PSTOL procedure execution (pause, resume, etc.)
See section 8 leading note.

PSTL 109 - Multiple PSTOL procedures can execute simultaneously, one per station.
Required revision, considering that stations can have many windows.

PSTL 110 (?) - Log all PSTOL inputs.
Not covered by current DLPs; do we need such complete logging? Curt believes that it would be appropriate to have such a log, at least extending some period of time (days?) into the immediate past.

PSTL 111 (?) - Allow one-shot program execution. (Provided by HST project).
I don't really understand the intent of this requirement. Curt notes that Joe Pilkington will likely have some good insights into the meaning and usefulness of this requirement.

PSTL 112* - Use of character data sets shall be permitted (to maintain operational logs).
Too low level.

Section 9 - Configuration Management Application Software (CMAS)
This refers to immediate configuration, in part the province of the resource manager - as opposed to the MUGSI system. Other than knowing that we want the CCS to be able to automatically reconfigure itself based on current situations (e.g., ground system anomaly, or telemetry format change), we have given only general thought as to how this happens.

CMAS 101* - Allocate CMAS node - *Resource Manager.*

CMAS 201 - CMAS interface shall use PSTOL.
See section 8 leading note.

CMAS 202 - The DOC shall provide the capability to switch various external interfaces to POCC communications channels (via PSTOL input).
This probably wants to change, to allow (a) MEs (rather than DOC personnel) to effect configuration changes, and (b) the CCS to reconfigure itself. Curt notes that it may be difficult to achieve item (b) if the current external interfaces remain.

CMAS 203 - PSTOL procedures shall exist to reconfigure the total ground system for changes in telemetry formats and rates.
Monitor system DLPs exist for automatic detection of format, with the understanding (at least in our discussions) that automatic switching would occur. Do we need the ability for human controlled switching as well? Curt thinks yes - for backup, and for testing (of, say, new terminals).

Monitor DLP for format detection: 4.2.1.1.6

CMAS 204 - Procedures for internal (PRS) interface testing shall be provided.
No interface test DLPs have been written. Curt thinks they are needed.

CMAS 205 - The DOC shall collect and display status information for all HST POCC system components.
Covered by Monitor system with respect to anomalies, but not for general status. Note comments following DSP 901.

CMAS 206 - Display (PRS) internal configuration history for last 162 configurations.
Logging of individual configuration changes not explicitly included in DLPs; is it needed? Curt thinks yes, note comments following DSP 901.

CMAS 207 - Collect and display status of all (PRS) CPUs, peripherals, & com links.
Covered by Monitor system vis-a-vis anomalies; not general status. See 206.

CMAS 208 - Coordinate HST POCC component interconnection configuration.
See section 9 leading note.

CMAS 209 - Coordinate connections between (PRS) AP and other POCC elements.
See section 9 leading note.

CMAS 210 - Coordinate connections between (PRS) TAC and other POCC elements.
See section 9 leading note.

CMAS 211 - Coordinate connections between (PRS) MVips and other POCC elements.
See section 9 leading note.

CMAS 212* - Coordinate connections between (PRS) SCR and other POCC elements.
SCRs probably to be discontinued.

CMAS 213 - Coordinate connections between (PRS) OLS and (PASS) OFLS.
No distinction between CCS OLS & OFLS.

CMAS 214 - Coordinate (PRS) printer assignments. (All physical printers equivalent.)
See section 9 leading note.

CMAS 215 - Coordinate ground file changes associated with flight software changes. (Pertains to Symbol of Interest, Dump Compare Range, DF-224 Safing Region, Table Formats, & Command Groups.)
DLPs required, but not written.

CMAS 216 - Select operational ORU/ORI pairs.
No DLPs exist for CCS responding to ORU changes. Curt thinks they'd be useful.

CMAS 301 (?) - "Remote Node Operational Modes" - no new requirements obvious here. (Perhaps someone could clarify what's intended by this.)

CMAS 302 - Initialize ("cold-start") MicroVip or SCR server.
No "cold-start" DLPs exist.

CMAS 303 - Collect and display status of all (PRS) CPUs, peripherals, & com links.
Covered by Monitor system vis-a-vis anomalies; not general status. See 206.

CMAS 304 - Provide test support for internal (PRS) server interfaces.
>*No interface test DLPs exist. Curt thinks they'd be useful.*

Section 10 - External Interface

EXT 101* - Allocate external interface subsystem node.
>*Implicit requirement exists, but not needed explicitly.*

EXT 102 - Communicate with NCC and DCF using acknowledgment protocols, with up to two retransmissions upon failures.
>*Protocols for communications with NCC & DCF have not been well defined. Curt comments that DCF is gone. The spirit of the requirement presumably still pertains to PACOR II.*

EXT 103 - Communicate with NCC to obtain network status and coordinate all scheduled TDRSS and Nascom services. (Includes acquisition of engineering link, establishing 1 Mb/s service for tape dump, and Ground Configuration Message Requests (GCMRs) on forward service.)
>*Covered by Monitor DLPs for obtaining status. From the C&U DLPs, it may be the case that C&U expects P&S to provide schedule, with no modifications expected.*
>*Monitor DLPs4.2.4.2.3, C&U DLPs ?????*

EXT 104 - Communicate with NCC to obtain network status and coordinate all scheduled TDRSS and Nascom services. (Includes GCMR responses & ODMs on return.) Provide NCC-supplied time delay measurement to OFLS (PASS) for clock correlation.
>*Covered by Monitor DLPs for obtaining status and time delay measurements. From the C&U DLPs, it may be the case that C&U expects P&S to provide schedule, with no modifications expected.*
>*Monitor DLPs 4.2.4.2.3, C&U DLPs ?????*

EXT 105 - Communicate with DCF regarding planned science telemetry operations and real-time STR dump operations, including UTC time stamps for STR dumps.
>*No DCF communications DLPs exist.*

EXT 106 - Communicate with OSS. Send science engineering data from engineering telemetry stream. Acknowledge OSS requests, e.g., command uplink verifications.
>*OSS can request engineering data like an;y other user. DLP 4.1.4.2.-*

EXT 107 - Communicate with ESS.
>*Monitor DLPs 4.1.1.6.- (for trending)*

EXT 108 - Send real-time engineering data to OFLS (PASS).
>*Monitor DLPs 4.1.1.7.-, 4.1.1.8.-, 4.2.3.2.-, 4.2.3.3.- (for AD, SC, & SM)*

EXT 109 - Support interface tests for the following interfaces: OLS/NCC, OLS/OSS, OLS/DCF, OFLS/FDF.
>*No interface test DLPs have been written. Curt opines that interface DLPs would be useful, although the connected subsystems will be different. (e.g., OLS & OLFS become CCS, FDF may interface only with P&S, DCF becomes PACOR.)*

EXT 110 - Gather data quality statistics regarding Nascom link and HST data stream.
>*Monitor DLPs 4.2.4.2.3*

EXT 111 - Test OLS & OFLS Nascom interface device drivers and message line.
>*No interface test DLPs have been written. Curt emphasizes needed for these.*

EXT 112 - Emulate NCC functions (for test): (a) acknowledgment protocol, (b) GCMR disposition message, (c) Operations Data Messages (ODMs), & (d) ODM activation / deactivation.
>*No interface test DLPs have been written. Curt emphasizes needed for these.*

Section 11 - Support

SUP 101* - Allocate Support Subsystem node.
>*Implicit requirement exists, but not needed explicitly.*

SUP 102 (*?) - Record user designated data types in a history log: (a) raw real-time data, (b) raw ETR data, (c) raw NSSC-1 dumps, (d) raw microprocessor dumps from science link, (e) raw NSSC-1 status buffers from science link, (f) raw DF-224 dumps, (g) HST command messages, (h) NCC messages, (i) system event messages, (j) derived telemetry, (k) OLS-DCF data blocks, & (l) telemetry data quality statistics.
>*The closest associated DLPs are those in the Monitor system for receiving and archiving data (4.2.1.1.1-4.2.1.4.5). No distinct DLPs exist for logging data to History files. Are they needed to protect against line-outage problems? Curt suggests that it may be useful for troubleshooting. We may want to consider this.*

SUP 103* - Delog user designated data over specified time periods: (a) events, (b) command blocks, (c) data quality statistics, (d/e) raw telemetry minor frames, (f) computed telemetry values.
>*The closest associated DLPs are those in the Monitor system for receiving and archiving data. No distinct DLPs exist for delogging data from History files. Are they needed to protect against line-outage problems?*

SUP 104 - Replay and process History and/or ETR telemetry data.
>*"Replaying" of data is from Archive. What is purpose?*

Section 12 - System Software

SYS 101* - Allocate System Software node.   -   *Resource Manager.*

SYS 201 - Communicate with NCC & DCF.
>*DLPs are partially complete. Monitoring system watches for configuration anomalies on required external systems, though DCF/PACOR appears not to have been included. DLPs for other communications have not been written. Monitor DLP 4.2.4.2.3*

SYS 202* - Provide SCR driver.
>*Replace SCR with CRT graphics.*

SYS 203 - Provide system time using GSFC-supplied UTC.
>*No explicit DLP has been written for this function. Do we need an explicit DLP?*

SYS 301* - Provide links between (PRS) computers.
>*Implicit requirement exists, but not needed explicitly.*

SYS 302* - Provide links between OLS-AP and MicroVIPs & SCR.
>*Implicit requirement exists for OLS-AP to MicroVIP communications.*

Replace SCR with CRT graphics.

Section 13 - Data Base
Considerable work is still required for defining data base operations. It is not obvious that this would be in the form of DLPs. Certainly the data group should be involved with - probably lead - this effort. (They are probably already doing so.)

DB 101* - Allocate Data Base node. - *Implicit requirement exists; not needed explicitly.*

DB 201 - Accept project data base input regarding: (a) telemetry formats, (b) telemetry decommutation, (c) telemetry calibrations/limits, (d) command formats, (e) command assembly, (f) command verification, (g) procedure definitions (PSTOL), (h) CRT and printer page formats, (i) SCR pen assignments, (j) line printer delog assignments, (k) computation algorithms and constants, (l) spacecraft constraints, (m) spacecraft characteristics, (n) OBC support, (o) servicing mission data, (p) PSTOL-form groups, (q) Other data (TBD).
    Implicit requirement exists for data base control. More work may be required.

DB 202 - Validate PRS required PDB input. - *DLPs not written.*

DB 203* - Incorporate required PDB information into PRS information data base (IDB).
    Implicit requirement exists, but not needed explicitly.

DB 204 - Provide Data Base Management System for PRS data. - *DLPs not written.*

DB 205 - Provide Data Base Security for PRS data. - *DLPs not written.*

DB 206 - Provide interactive PRS IDB update capability. - *DLPs not written.*

DB 207 - Provide PSTOL syntax validation capability. - *DLPs not written.*

DB 301* - Generate PRS Operational Data Base (ODB) from IDB.
    Implicit requirement exists, but not needed explicitly.

DB 302 - Generate ODB report listing. - *DLPs not written.*

DB 303 - Generate difference listing from comparison of two ODBs. - *DLPs not written.*

DB 304 - Provide capability to create, store, and modify executable procedures independent of the data base build process.
    Is this part of MUGSy? Do DLPs exist?

DB 401 - Log interim PDB changes. - *DLPs not written.*

DB 402 - Provide tool for PSTOL procedure validation. - *DLPs not written.*

DB 501* (?) - Store up to four data bases at remote node.
    DLPs for analogous functions not written.

Section 14 - System Performance
DLPs are not written as performance requirements. The SEs, or similarly knowledgeable folks, should review current performance requirements and decide how they should map to the new CCS.

PER 101 - PRS LAN CPU < 50%. PRS LAN CPU for any node element < 80%.

PER 102 - LAN traffic < 30%. EDB delays < 1 s. Command delays < .5 s.

PER 103 - PRS CPU availability > 0.9975.

PER 104 - Component initialization requirements.

PER 105 - TAC playback rates.

PER 106 - History log playback rates.

PER 107 - PSTOL directive execution rate (> four statements per second).

PER 108 - CRT Display update rates (> once per second).

PER 109 - SCR performance (> 40 samples per second).

PER 110 - ORU/ORI selection (within one minute).